

## Freeze Resistant Buoy System

The United States Government has rights in this invention pursuant to contract no. DE-AC05-00OR22725 between the United States Department of Energy and UT-Battelle, LLC.

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### CROSS-REFERENCE TO RELATED APPLICATIONS

Specifically referenced is commonly assigned U.S. Patent Application Serial No. 10/489,316 filed on even date herewith, entitled "Enhanced Monitor System for Water Protection", the entire disclosure of which is incorporated herein by reference.

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### FIELD OF THE INVENTION

The present invention relates to freeze resistant buoy systems, and more particularly to freeze resistant buoy systems that draw heat from deeper water to prevent freezing of the buoy systems.

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### BACKGROUND OF THE INVENTION

Currently available buoy systems may be susceptible to freezing, disabling the activity of systems contained therein. For example, recent terrorist attacks in the United States have increased the awareness of the need for ways to protect drinking water supplies. Source waters for civilian populations and military facilities are vulnerable to such attacks. There is therefore a need for improved real-time water quality sensor systems that quickly and accurately detect toxic materials in a water source and transmit an indicative signal. In climates where water supplies freeze over during cold seasons, there is a need to protect such systems, and other buoy-mounted systems, from freezing.

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Specifically referenced is commonly assigned U.S. Patent No. 6,569,384 issued on May 27, 2003 to Greenbaum, et al. entitled "Tissue-Based Water Quality Biosensors for Detecting Chemical Warfare Agents", the entire disclosure of which is incorporated herein by reference.

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Specifically referenced is U.S. Patent No. 3,170,299 issued on February 23, 1965 to Clarke, entitled "Means for Prevention of Ice Damage to Boats, Piers, and the Like", the entire disclosure of which is incorporated herein by reference.

transfer fluid such as water, fluorinert™ (available from Hampton Research, 34 Journey, Aliso Viejo, CA 92656-3317), acetone, or alcohol, for example.

The thermo-siphon 202 operates as follows: Sensible heat from deeper water 240 warms the bottom 204, and the porous material 208. The heat transfers to the heat transfer fluid which evaporates and rises to the waterline region 206. The heat transfer fluid condenses on the coldest part of the thermo-siphon 202, transferring the heat to the waterline region 206. The latent heat of condensation is usually sufficient to keep ice from forming, thus keeping the buoy free. The condensate then drains down to the bottom 204 for recycle and further evaporation. Hence, a totally passive vapor chamber rapidly transfers sensible heat from deeper water to the waterline region 206 of the buoy. The fluid transfer rate will change to accommodate the changes in heat duty due to environmental changes. Hence, during colder weather, more vapor will be generated, and during warmer weather, virtually no vapor will be generated. Selection of heat transfer fluid can be made with considerations of estimated service location, duty cycle, heat duty of the system, environmental conditions, and other factors.

The thermo-siphon 202 can be extended below the bottom of the buoy, or the buoy itself can be elongated in order to reach deeper, warmer water 240. Moreover, the thermo-siphon 202 may be enhanced by increasing the surface area of internally and/or externally thereof by any known means, such as, for example, flutes, fins, perforations, folds, etc. Fins 232 are shown at the bottom 204 in Fig 1 as an example.

The Buoy can house a variety of mechanical, chemical, biological, electrical, electronic, sonic, optical, and/or other systems for collecting and analyzing samples of air, water, electromagnetic energy, other types of energy, and other materials.

In another embodiment of the present invention, shown in Fig, 2, the present invention includes a remotely controlled, buoyant device for detecting toxic agents in water sources using chlorophyll fluorescence monitoring. This device, described in U.S. patent Application Serial No. 10|689,316, is designed to make rapid remote assessments of possible toxic contamination of source waters (reservoirs, rivers, lakes, etc.) prior to entry to drinking water distribution systems. It provides around-the-clock unattended monitoring and uses naturally